MOVIETONE BULLETIN

Published in the interest of the Movietone Projectionist by

FOX CASE CORPORATION

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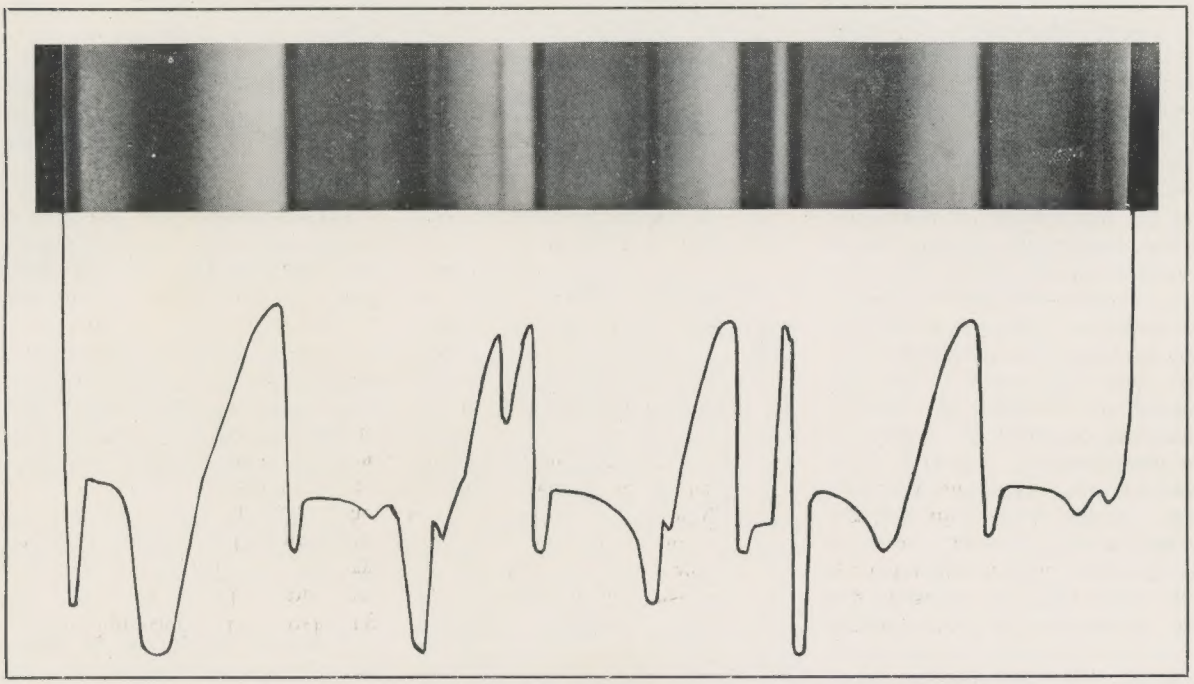
The Movietone Sound Track



This picture shows the sound track magnified to thirty times its original size. Beneath the strip of sound track are shown the corresponding percentage transmissions of total light.

AN explanation of the movietone system of recording and projecting quickly dispels the mystery of the sound track. The pressure of sound waves impinging on the diaphragm of a condenser microphone, (as distinguished from a carbon microphone), causes the diaphragm to vibrate. The amount of the displacement of the diaphragm is proportional to the intensity or loudness of the sound. This movement varies the capacity of the condenser microphone, thus altering the charge on the grid of a vacuum tube which is connected in series with the microphone. The resulting alternating current is proportional and in phase with the movement of the diaphragm.

If a carbon microphone is used, the displacement of the diaphragm varies the resistance of the microphone and causes a varying or modulated direct current. This current may be considered as made up of a direct and alternating component.

After several stages of amplification in which the voltage is increased approximately 100,000 times, it is impressed on an Aeo light. The Aeo light is a gas tube excited by direct current and so designed that its intensity or brightness is proportional to the applied voltage. The light shines through a narrow slit on a moving negative film in the camera and the variations of the light are recorded upon it. The exposure of the film is in phase and proportional to the alternating voltage applied to the Aeo light. Thus the sound track is a record of the exposure due to the variations in brightness of the Aeo light.

In reproducing, the printed sound track is passed through a narrow light beam, (.001" x .08"), of constant intensity and the transmitted

light falls on a photo-electric cell. With proper developing and printing the light transmitted through the print is proportional to the exposure of the negative at the corresponding point. The resistance of a photo-electric cell varies inversely proportionately to the light shining on it. Thus the current flowing through the cell is proportional to the light transmitted through the film. The voltage drop across a series resistance in the cell circuit is impressed on the grid of the first tube of an amplifier. After it has been amplified approximately 100,000 times, this voltage is impressed on a loud speaker and the diaphragm moves proportionately. As the amplification is accomplished without appreciable distortion the movement of the diaphragm of the loud speaker is proportional to the movement of the diaphragm of the microphone and the sound which was recorded is reproduced.

We are now in a position to analyze the sound track. If the source of the sound to be recorded has a frequency of 60 cycles, the Aeo light intensity will rise to a maximum, fall to a minimum and return to normal 60 times every second. The film moves 90 feet per minute or 18 inches per second. Therefore on every 18 inches of film there will be found 60 light and 60 dark striations, .15 inch wide. If the frequency were increased to 6000 cycles the width of the striations would decrease to .0015 inch. Thus the width of the band on the sound track is a measure of the frequency of the sound recorded. The difference in shade between the light and dark bands is a measure of the intensity of the sound.

As most bodies vibrate or tend to vibrate in harmonic motion, the sound waves gradually increase and decrease. Therefore the striations usually are not sharp but gradually fade from one to another.

This simple example of recording a single fixed frequency is seldom met in practice. The fundamental frequencies of the human voice vary from 60 to 1300 cycles and the overtones are as high as 10,000. Two musical tones from different instruments of equal intensity and frequency, but of different quality, will differ in the manner in which one striation fades into another. In orchestral recording many frequencies varying over the entire audible range of 20 to 10,000 cycles should be recorded at the same instant. The resulting sound track showing all of the varying frequencies is extremely complex and shows practically no uniformity or regularity.

The accompanying picture is that of a strip cut from the center of a sound track and magnified to 30 times its original size. Plotted vertically under it are the approximate corresponding percentage transmissions of total light. As stated during the course of the text, this graph with a variable vertical scale could represent:

(1) The vibration of the diaphragm of the microphone.
(2) The microphone current.
(3) The Aeo light voltage.
(4) The intensity of the Aeo light.
(5) The exposure of the negative.
(6) The transmission of the print.
(7) The illumination of the photo-electric cell.
(8) The photo-electric cell current.
(9) The voltage impressed on the loud speaker.
(10) The vibration of the diaphragm of the loud speaker.

Careful About Oil

WHEN oiling the projectors, spend a couple of extra minutes and do the job right. If you put more than one, or at most two drops of oil in any projector bearing, all over that amount will just run out, smear around, make a nasty mess and in all human probability get on the films. Flooding bearings with oil does not increase their life appreciably. It merely wastes oil, dirties things up and gets the films smeared more or less, to the damage of your own show and the show of those who must use the films after you are through with them.

Another thing: Don't use a too-thin oil. Such oils run out of bearings quickly and are easily thrown off rotating parts. Use the oil recommended by the projector manufacturer by preference. If you can't or you won't do that, then consult your Bluebook of Projection, page 626, Vol. 2, and be guided by what you find there.

If oil seeps out of the intermittent oil well through the shaft bearings, it is up to the projectionist to provide a wiper which will take up the seepage and carry it down to an absorbent pad placed in the base of the mechanism to receive it. Don't tell me you cannot do it, else I will lose respect for your ingenuity and ability.

Oil gets on film because of (a): Seepage from the intermittent oil well which is not collected by a suitable wiper, and (b): By reason of over-oiling. There is no possible excuse for permitting oil to get on film. He who does permit such a thing has no right place in a projection room. We do not believe any movietone projectionist does permit it, and are glad to be able to say so.

FLICKERS

The children were eating animal crackers and naming the animals as they took them out of the box. Suddenly they took out a pretzel. They looked at it in amazement. Then one of them exclaimed: "I know what it is. It is Lon Chaney!"

If it takes a ticket to get into heaven a lot of people will want a rain check.

It's nice to be an Eskimo husband. When he doesn't come home for five or six months the family just think he is out to some night club.

Did you hear about the absent-minded bandit? He bound and gagged the safe and robbed the night watchman.

Advertisements tell us that four people out of five have pyorrhea. The fifth, we take it, has false teeth.

It used to be men wanted a wife who cooked like mother used to cook. Now they are content with a wife who knows a delicatessen store like mother used to patronize.

Don't get in the habit of guessing things are all right. Graveyards are full of guessers.

Movietone is yet but an infant. But that is no reason why you should be careless with it and permit it to sound like one.

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The Motor Control Box

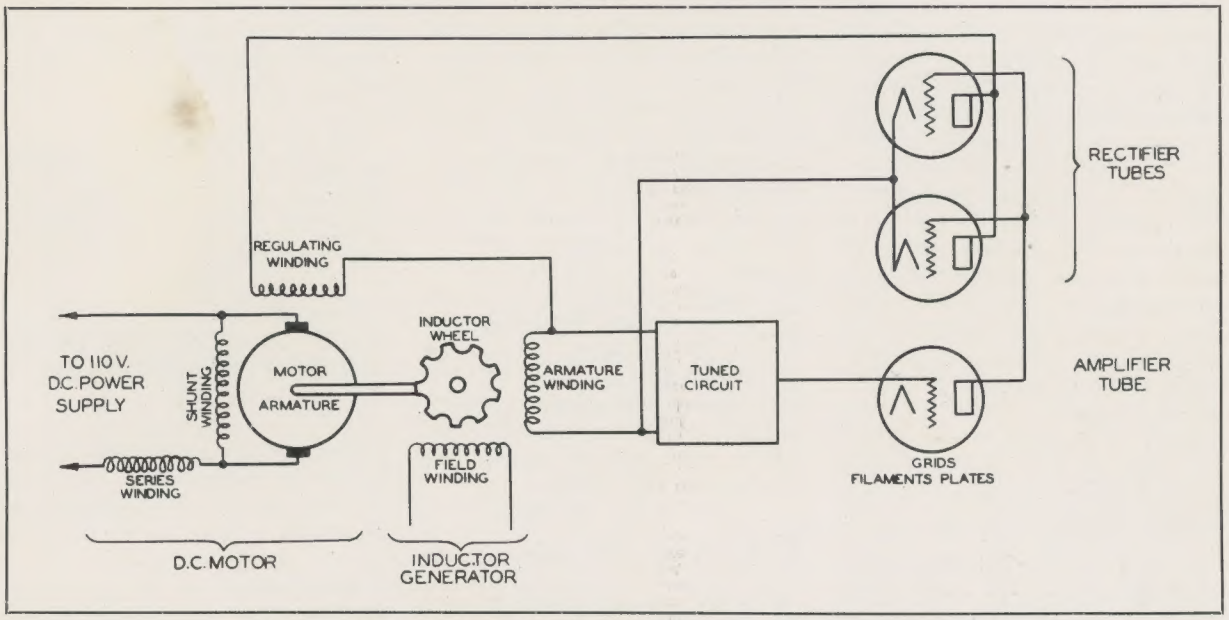

Fig. 1. Simplified diagram, showing action of D. C. motor and control box.

EVERYBODY who has attempted to develop a system for synchronizing sound with pictures has found, before long, that the recording and reproducing of the sound accompaniment, and its synchronization with the picture, were not the whole of the problem. A very important question, it was soon realized, was the driving of the mechanism at the correct speed. In this connection, three things are essential:

1. Not only must the sound be reproduced in synchronism with the picture—this can be done comparatively easily by driving both the projector and the reproducing mechanism with the same motor—but also the speed of the reproducing equipment must be exactly the same as the speed at which the picture was taken and recorded. The reason for this is that if a sound record is played at a faster or slower speed than it was recorded, there will be a distortion of the voice or music, which makes it sound unnatural. This you can easily verify by a little experimenting with a record on a good phonograph, one where departures from high quality reproduction are readily noticeable. The standard film speed for all Western Electric disc and film recording and reproducing is 90 feet per minute, or 18 inches per second. The drive gearing used is such that this requires a motor speed of 1200 R.P.M.
2. Not only must the reproducing speed be the same at which the picture was taken and recorded, but this speed must be kept very steady indeed—it cannot be allowed to vary by more than a very slight percentage, despite all ordinary changes in load and in supply voltage. Otherwise fluctuations in pitch will be constantly noticed in the reproduced sound, causing the voice to seem shaky and the music out of tune. Here again, the effect referred to has at some time been noticed by nearly everyone, in listening to a phonograph which did not have a very good governor.
3. In addition to the foregoing requirements it is also necessary, of course, to be able to regulate the motor speed in the usual manner when silent pictures are being shown.

The function of the motor control box and special motor used with Western Electric reproducing equipment is to meet the three requirements just stated. Readers with some knowledge of electric motors may here ask why the constant speed requirements could not be made by using a compound wound motor on D.C. or a synchronous motor on A.C., as these are usually considered to be constant speed machines. With regard to the compound D.C. motor, the answer is that while for ordinary industrial purposes this is true, yet under common fluctuations of load and voltage, the speed regulation of such motors is not close enough to meet the very exact require-

ments of synchronized sound reproduction; and in the case of the synchronous A.C. motor, there are the objections that it does not have a very good starting torque, and that speed regulation, such as is required for running silent pictures, could not be obtained. Evidently, therefore, the problem is one which requires new methods for its solution.

Before describing the operation of the motor control box it is necessary to explain one important special electrical feature on which its operation depends. This is what is called a "tuned" or "resonant" circuit. This means a circuit which will permit alternating current of a certain frequency to pass fairly readily, but which offers a high resistance to alternating currents of any other frequencies. The frequency which such a circuit is designed to pass is called the "tuned" or "resonant" or "critical" frequency. Perhaps this phenomenon will appear less mysterious if it is stated that exactly the same thing happens in mechanical engineering and can be illustrated very simply. Take a piece of rubber band and, holding it by one end, hang on the other end some object heavy enough to stretch it moderately. The weight will bounce up and down at a regular rate and a touch will be enough to keep it going. But if you try to move it faster or slower than this natural rate, you will find that the rubber band gives you very little assistance and you will have to do most of the work yourself. In other words, this is a mechanical arrangement which readily permits back-and-forth movement at a certain frequency, but offers considerable resistance to movements at other frequencies, just as we said previously was the case with a "tuned" circuit. It has a mechanical "resonance" effect. Any combination of mass and elasticity will act the same way—for instance, this is the reason why the prongs of a tuning fork display their property of vibrating at a constant pitch. Now in electrical engineering a choke coil or inductance has the same effect on an electric circuit that a weight, (or more properly a mass, such as a flywheel), has on a mechanical device, and a condenser plays the same part electrically that a rubber band, spring, or other elastic member does mechanically. An alternating current is nothing but a back-and-forth movement of electricity in a circuit; and, therefore, by using a circuit consisting of a choke coil and a condenser, it is possible to create resonance effects, such as were just mentioned; fundamentally, that is all there is to a "tuned" circuit.

In providing speed control for the motor, the first thing necessary is to have some means by which the motor can, so to speak, signal to the control box to show at what speed it is running. This is done very effectively by simply building into the motor a small A.C. generator, on the same shaft and within the same housing. This generator produces alternating current whenever the motor is running, of course, and the frequency of this alternating current will always be exactly proportional to the speed of the motor at each moment. Thus the A.C. generator acts as a pilot or speed indicator. When the motor is running at the standard speed of 1200 RPM, the generator is producing alternating current at a frequency of 720 cycles per second—below 1200 RPM of the motor, the generator frequency is below 720 cycles per second, and vice versa.

(Concluded in next issue.)

Keep Sound Gate Clean

AGAIN, for the benefit of both old and new movietone projectionists, we caution you concerning the sound gate, just a little accumulation of dirt upon the face of which may, and in all human probability will seriously injure or ruin a lot of sound band, which of course means a lot of film.

Before you thread up, make it your invariable practice to run a finger over the surface of the sound gate with which the sound band comes into contact, and if the slightest roughness is felt, remove it by rubbing with either a moistened finger or cloth. Never scrape a deposit off. If you do you will roughen the polished metal and add to the likelihood of further deposit. A moistened finger or cloth is the only right way to remove such deposits.

FLICKERS

Get the sound regulated for movietone before the show starts. When you experiment with the fader while the show is running the audience thinks every singer is trying to yodel.

The constitution guarantees everybody life, liberty and the pursuit of happiness. Traffic laws are to keep people from pursuing happiness at a rate of eighty or ninety miles an hour.

Back in the Bible times it rained forty days and forty nights to make a flood. A projectionist can give the bearings one in ten seconds by over-oiling.

All the important men around an office are minute men. When they are out the stenographers always tell you they are expected back any minute.

Thanksgiving Day is coming. That is the day on which you are supposed to eat turkey instead of talk it.

There are sprocket idlers in your projection mechanism. They are the only kind of idlers supposed to be around a booth.

Some women do not like a man with a past. All women like a man with a present.

Many a young man points with pride to the house that Jack built. Father's jack.

They used to say that actions speak louder than words. But that was before movietone was invented.

A merchant and an acrobat are a great deal alike. Both depend to a great extent upon the turnover.

Whatever your problem, do the best you can. If that isn't good enough, do better.

Movietone talks like a human being. But unlike a human being it doesn't talk to itself.